

TEST REPORT
E.I. DU PONT DE NEMOURS & COMPANY
EXPLOSIVE RELEASE P/N X-696

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CORPORATION

CHRYSLER CORPORATION
SPACE DIVISION

CCSD-FO-1060-3S PHASE D

TEST REPORT

E. I. DU PONT DE NEMOURS & COMPANY
EXPLOSIVE RELEASE P/N X-696

ABSTRACT

This report presents the results of acoustic testing conducted on the E. I. Du Pont De Nemours and Company Explosive Release Part Number X-696. The test was conducted to determine whether the explosive release could withstand the acoustic levels for Launch Complex 34 and Launch Complex 37 without detonating and with no degradation of performance. The acoustic levels to which the explosive release was subjected were taken from the "Acoustic and Vibration Environment and Test Specification Levels Ground Support Equipment Launch Complex 39" manual number SP-4-38-D, Revised July 27, 1964, for zone 1.1.2 during lift-off. The results of this test show that the Explosive Release Part Number X-696 will withstand the acoustic levels with no failures or degradation of performance.

JOHN F. KENNEDY SPACE CENTER

CCSD-FO-1060-3S PHASE D

TEST REPORT

E. I. DU PONT DE NEMOURS & COMPANY
PART NUMBER X-696
EXPLOSIVE RELEASE

25 OCTOBER 1966

SYSTEMS ENGINEERING TEST UNIT
LAUNCH ENGINEERING BRANCH

FOREWORD

This document has been prepared for the National Aeronautics and Space Administration, Kennedy Space Center, Launch Support Equipment Engineering Division, Systems Support Branch.

The test was conducted in accordance with Test Plan CCSD-FO-1060-1S, Phase D of contract NAS8-4016, KSC Modification 1, Task 15, Test Change Proposal 0005. The test was performed at Wyle Laboratories, Huntsville, Alabama, witnessed by Chrysler Corporation, Space Division, Florida Operations.

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COMPONENT CHECK LIST
FOR
EXPLOSIVE CHARGE

MANUFACTURER: E. I. DuPont DeNemours & Company, Inc.
Wilmington, Delaware

MANUFACTURER'S PART NUMBER: X-696

TEST AGENCY: Wyle Laboratories, Huntsville, Alabama

CONTRACTING AGENCY: Chrysler Corporation, Space Division
Florida Operations

AUTHORIZING AGENCY: NASA/KSC, MH-2

I. FUNCTIONAL REQUIREMENTS

- A. No Fire Current: 1 Ampere minimum
- B. No Fire Power: 1 Watt minimum
- C. Functioning Time: Less than 15 milliseconds when subjected to 10 amperes firing current.

II. A. Shorting Bar: Aluminum

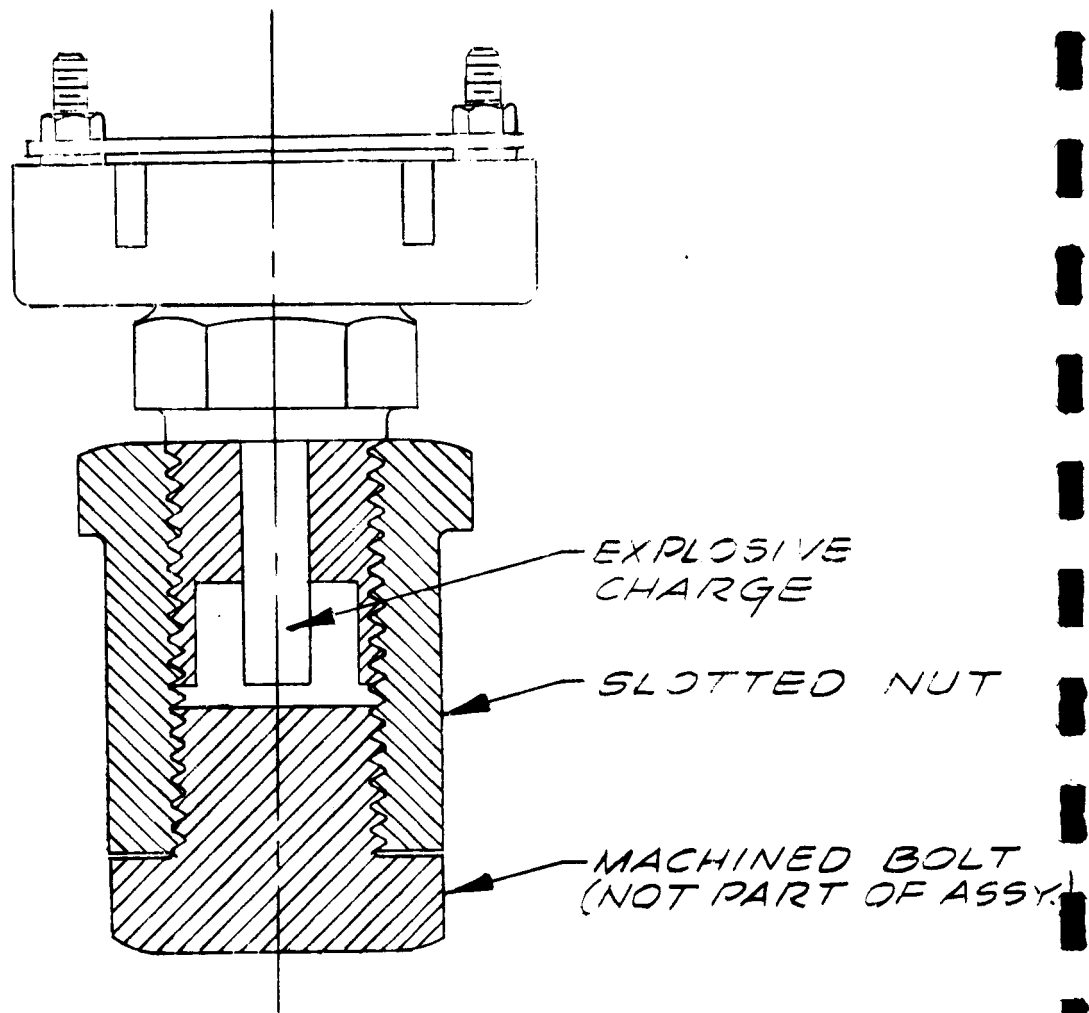
- B. Insulated Plastic Body: "Alathon" 20 or 38
- C. Metal Parts: Nut, bolt, and special slotted nut of Non CRES. Hex Bar to specification 8630 MIL-S-6050 OPT. 4130 MIL-S-6758 (ASG), and all machined surfaces cadmium plated per QC-P-416 Type I, Class II. The bolt is a 7/8"-14UNF -3A per specification MIL-S-7742.
- D. Leg Wires (Explosive Charge): Nylon insulated, one blue and one yellow, 22 gage (AWG) tinned copper wire.
- E. Rubber Plug (Explosive Charge): Split rubber plug assembly secured to leg wires having a welded bridge wire covered with Special DuPont Bead mix (proprietary).
- F. Crimps (Explosive Charge): Completely around shell.
- G. Shell (Explosive Charge): Commercial bronze.
- H. Base Charge: 14.5 grains RDX (Cyclo-trimethylene-trinitramine)
- J. Primer Charge: 4 grains lead azide

III. ELECTRICAL CHARACTERISTICS

- A. Resistance: 0.29 ± 0.07 ohm plus 0.032 ohm for each double foot of leg wire.

IV. LOCATION AND USE

The explosive release is to be used on the holddown arm system on LC-34 and LC-37 GSE. The explosive release is a backup or redundant release in series with the primary pneumatic release subsystem.



FRONTISPIECE

TEST SUMMARY SHEET
EXPLOSIVE RELEASE - DUPONT P/N X-696

ENVIRONMENT	NO. OF UNITS	OPERATIONAL BOUNDARY	TEST OBJECTIVE	TEST RESULTS	REMARKS
Receiving Inspection	12	Manufacturer's Specifications	To determine as received condition of specimens by visual and dimen- sional inspection and resistance measurements	Satisfactory	Specimens identified by numbering 79 thru 90.
Acoustic	10	Overall Sound Pressure Level of 178 db	To verify that specimens would not detonate, suffer damage, or func- tionally deteriorate	Satisfactory	Specimens 81 thru 90 were subjected to the environment one at a time, 5 in a horizontal axis and 5 in a vertical axis.
Final Inspection	12	Initial Resistance and appearance	To determine that the internal resistance had suffered no signi- ficant change & that the specimen had sustained no apparent physical damage	Satisfactory	Specimens 79 and 80 were used for comparison. All results were compared with original results. (Receiving Inspection).
Detonation	12	10 amperes approx- imate firing current, time-to- detonate recorded.	To see that all bolts would detonate successfully in approximately the same time.	Satisfactory	Specimens 79 and 80 were detonated as a basis of comparison and for equipment checkout. Specimens 81 thru 89 were fired without special slotted nut, specimen 90 fired in special slotted not with blanking plug in open end.

SECTION I

INTRODUCTION

1.1 SCOPE

- 1.1.1 This report presents the results of tests performed to determine if the explosive release, manufactured by E. I. DuPont DeNemours and Company part number X-696, meets the operational requirements during and after subjection to an acoustic environment such as will be encountered at John F. Kennedy Space Center Launch Complexes 34 and 37. The acoustic test level was selected after an analysis of available data, recorded on LC-34 and LC-37 during previous launches.
- 1.1.2 Ten explosive releases were selected as a sample lot and subjected to the acoustical test as specified in this report. The acoustic tests were performed in a 50 cycle exponential horn driven by an air modulator.

1.2 ITEM DESCRIPTION AND USE

- 1.2.1 The explosive release is constructed of five basic parts: (1) A shorting bar placed across the terminals of the device during shipment and handling. This bar is removed at the time of installation; (2) An insulated plastic body through which the leg wires are drawn for attachment to the terminals. This plastic body is attached to the bolt by a SAE thread 1/2" -20 nut; (3) A 7/8"-14UNF-3A bolt which has been hollowed out to receive the explosive charge; (4) An explosive charge, DuPont P/N X-692, which is inserted into the bolt. This charge is detonated by the application of a current in excess of 3.6 amperes; (5) A special slotted nut into which the 7/8"-14UNF bolt is threaded. Detonation of the explosive charge (inside the bolt) causes the slotted nut to split open at the slot.
- 1.2.2 An Explosive Release is to be used in each of the eight holddown arm release assemblies on Launch Complexes 34 and 37. Its function is to serve as a redundant (backup) mode to the primary pneumatic release. Should pneumatic separation fail to occur within the required time a current of 10 amperes will be applied to the explosive charge. Detonation of the explosive charge will cause the special slotted nut to split releasing an eye bolt and assuring separation.

1.3 REFERENCE DOCUMENTS

- 1.3.1 Test Plan, CCSD-FO-1060-1S, Phase D.
- 1.3.2 Manufacturer's Drawing No. 793 (for DuPont 7/8 inch diameter explosive release (X-696), No. 794 (Shorting Bar), No. 322D (insulated Plastic Body), No. 327A (Metal Parts for 7/8 inch DuPont Explosive Release), No. 788 (DuPont X-692 One-Amp, One-Watt No-Fire E. B. Cap).
- 1.3.3 KSC-STD-164 (D), Standard Environment Test Methods for Ground Support Equipment Installations at Cape Kennedy, September 17, 1964.
- 1.3.4 SP-4-38-D, Acoustic and Vibration Environments and Test Specification Level Ground Support Equipment Launch Complex 39, Revised July 27, 1964.

1.3.5 KSC-STD-128-(D), Standard Test Reports, Preparation of, June 5, 1965.

SECTION II
RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

- 2.1.1 This test was performed to verify that the test specimens met the visual and dimensional requirements of all applicable manufacturer's drawings and specifications. The inspection also included making an accurate determination of the resistance of the explosive charge.

2.2 TEST PROCEDURE

- 2.2.1 The equipment used to perform the receiving inspection is listed in Table 2-1.
- 2.2.2 The test specimens were numbered 79 through 90 for identification, with the exception of the special slotted nuts, which were not separately identified because of their similarity. Also, only two slotted nuts were used for the remainder of the tests. Although the Test Plan called for testing ten specimens, twelve were made available.
- 2.2.3 A visual inspection of the test specimens was made to determine that they were in good physical condition.
- 2.2.4 The specimens were dimensionally checked to determine that the external dimensions were in conformance with the manufacturer's drawings. A dimensional drawing of the specimens (as per manufacturer's drawings) is shown in Figure 2-1.
- 2.2.5 The electrical resistance of each explosive charge was measured and recorded.
- 2.2.6 Safe handling procedures were observed throughout this test.

2.3 TEST RESULTS

- 2.3.1 All specimens appeared to be in good physical condition.
- 2.3.2 The dimensions of the 7/8"-14UNF bolt and insulated plastic body are shown in Table 2-2. The manufacturer did not supply a dimensional drawing of the special slotted nut, but outside dimensional measurements were made and these are recorded in Table 2-3.
- 2.3.3 The electrical resistance of each explosive charge is recorded in Table 2-4.

TABLE 2-1 Receiving Inspection Equipment List

ITEM NO.	NOMENCLATURE	MANUFACTURER	MODEL PART NO.	SERIAL NO.	REMARKS
1	Outside Calipers	N/A	N/A	N/A	0.001 Accuracy
2	Scale	N/A	N/A	N/A	0.01 Accuracy
3	D-C Micromultimeter	Dynamics Instruments	4132	4132-0068	1×10^{-4} Volts $1 \times 10^{+3}$ Volts Range Calibrated 8-23-66

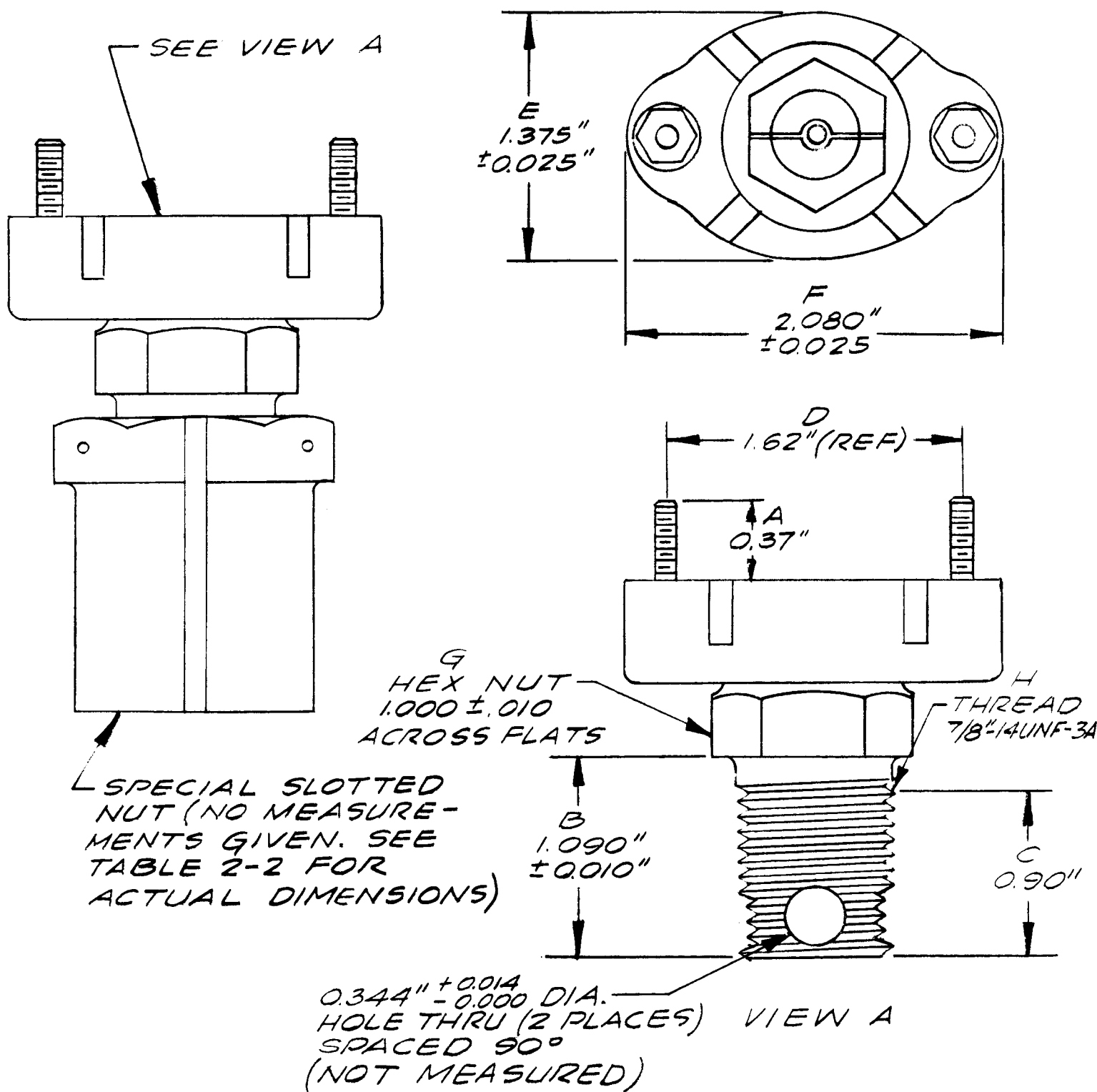


FIGURE 2-1 DUPONT EXPLOSIVE
RELEASE PART NO. X-696

TABLE 2-2 Dimensions-X696 Explosive Bolts

SERIAL NO.	G	H	A	B	C	D	E	F
ACTUAL DIM.	1.000±0.10	7/8	0.37 Ref.	1.090±0.018	0.09	1.62 Ref.	1.375±0.025	2.080±.025
79	1	.870	0.375	1.090	0.925	1.670	1.375	2.090
80	1	.870	0.350	1.090	0.925	1.670	1.375	2.100
81	1	.875	0.375	1.090	0.925	1.675	1.375	2.080
82	1	.875	0.375	1.090	0.925	1.670	1.365	2.090
83	1	.870	0.385	1.090	0.925	1.670	1.365	2.100
84	1	.875	0.375	1.100	0.950	1.670	1.375	2.090
85	1	.870	0.375	1.100	0.950	1.720	1.375	2.115
86	1	.865	0.375	1.090	0.950	1.670	1.375	2.090
87	1	.875	0.375	1.090	0.925	1.680	1.365	2.090
88	1	.875	0.375	1.090	0.925	1.680	1.370	2.090
89	1	.870	0.390	1.080	0.950	1.700	1.375	2.120
90	1	.875	0.400	1.087	0.950	1.670	1.370	2.120

NOTE: All dimensions in inches

TABLE 2-3 Dimensions - Special Slotted Nut

LENGTH	DIA.	HEX ACROSS FLATS	SLOT WIDTH
1.640"	1.350"	1.375"	.90
1.635"	1.350"	1.375"	.90
1.635"	1.355"	1.375"	.90
1.630"	1.350"	1.375"	.95
1.625"	1.355"	1.370"	.95
1.625"	1.355"	1.375"	.100
1.640"	1.350"	1.370"	.100
1.660"	1.355"	1.370"	.100
1.645"	1.345"	1.375"	.100
1.650"	1.360"	1.375"	.95
1.650"	1.350"	1.370"	.100
1.645"	1.350"	1.370"	.100

TABLE 2-4 Resistance Measurements Prior to Acoustic Tests

Serial No.	79	80	81	82	83	84	85	86	87	88	89	90
Resistance (ohms)	0.43	0.42	0.455	0.42	0.40	0.40	0.44	0.44	0.42	0.44	0.44	0.44

SECTION III

ACOUSTICS

3.1 PURPOSE

- 3.1.1 This test was performed to determine if the explosive charge (DuPont P/N X-692, part of explosive release, DuPont P/N X-696), when subjected to an acoustical environment as an assembly, is adversely affected.

3.2 REQUIREMENTS

- 3.2.1 The test was conducted in accordance with KSC-STD-164 (D), Section 9, Test Procedure II (Progressive Wave), using an acoustic test spectrum level as defined in SP-4-28-D (Revised July 27, 1964), for zone 1.1.2 for lift-off levels. Exceptions to these requirements were allowed, and are noted in the procedure, to accommodate the test equipment and to bring the test more in line with realistic parameters (i.e. KSC-STD-164 (D) calls for an exposure time of 15 minutes, this was reduced to 3 to 5 minutes for this test). Electrical continuity of the specimens was monitored continuously during exposure to acoustics.

3.3 TEST CONDITIONS

- 3.3.1 The acoustic environment used for the tests comprised a progressive wave, broad band random noise with an overall Sound Pressure Level of 178 db (re. 0002 dynes/cm² See Table 3-2) and a spectrum as shown in Figure 3-1. Also shown in Figure 3-1 is the required spectrum which was to be matched as closely as possible.
- 3.3.2 As will be noted in Figure 3-1, the lower frequency levels could not be matched due to equipment limitations. However, comparison of the specimen dimensions with the acoustic wave lengths involved at these low frequencies indicate that this response fall-off was unimportant.
- 3.3.3 These tests were conducted out-of-doors. The sky was overcast during the entire time of testing with sporadic rainfall, heavy at times. The temperature varied from the mid-fifties to the low sixties.

3.4 PROCEDURE

- 3.4.1 The equipment used during this test is listed in Table 3-1.
- 3.4.2 A blanking plug (machined bolt, see Figure 3-2) was inserted into the special slotted nut and torqued to 25 ft.-lbs. This was to simulate actual installed conditions as nearly as possible.
- 3.4.3 The blanking plug and special slotted nut was mounted on an elastic cord and stretched across the diameter of a 50 cycle exponential horn (See Figure 3-4) at a point where the required Sound Pressure Level could be achieved. At this point the horn diameter was nine inches (see Figures 3-3, 3-4 and 3-5). Only one specimen at a time was mounted as it was felt that to put more than one specimen into the available space would have an adverse effect upon the overall Sound Pressure Level and make it more difficult to achieve the desired test spectrum.

- 3.4.4 A microphone was installed in the test area adjacent to the specimen (See Figures 3-3 and 3-5).
- 3.4.5 The bolt containing the explosive charge was inserted into the special slotted nut and this assembly was then oriented in its proper axis (See step 3.4.8 below).
- 3.4.6 The explosive release assembly was then connected to the circuit shown in Figure 3-2 for monitoring of continuity.
- 3.4.7 An acoustic test run was made for approximately four minutes duration, during which three complete one-third octave band analyses were made of the acoustic data. A sample of this acoustic data is shown in Figure 3-6.
- 3.4.8 Steps 3.4.1 through 3.4.7 were repeated for each of the ten specimens. Five of the specimens were mounted along the axis of the horn and five of the specimens were mounted across the horn diameter (See step 3.4.5).

3.5 RESULTS

- 3.5.1 No damage to the specimens was observed as a result of acoustic testing.
- 3.5.2 No specimens were caused to detonate as a result of exposure to the acoustic environment.
- 3.5.3 No interruption of electrical continuity was observed during exposure to the acoustic environment.
- 3.5.4 A typical one-third octave band analysis of the sound field measured by the microphone during the tests is shown in Figure 3-6.
- 3.5.5 Proper safe handling techniques were observed throughout this test.

TABLE 3-1 Acoustic Test Equipment List

ITEM NO.	NOMENCLATURE	MANUFACTURER	MODEL PART NO.	SERIAL NO.	REMARKS
1	Battery	N/A	N/A	N/A	24 Volts
2 & 3	Resistor (2 required)	N/A	N/A	N/A	1 ohm 100 watts
4	Snap Action Switch	Micro-Switch	N/A	N/A	Heavy duty 15 ampere rating
5	Resistor	N/A	N/A	N/A	47 ohm 50 watts
6	Visicorder	Honeywell	1012	N/A	Calibrated 6-3-66
7	Ammeter	Weston	931	61979	Range 0-10 amperes Calibrated 10-18-66
8	Microphone	Photocon	524	PRP74-76	Range 200 db
9	Calibrator	Photocon	PC120	112	Range 170 db Calibrated 9-3-66
10	Audio Frequency Spectrometer	B and K	2112	77561	Range -60 to +50 db Calibrated 10-17-66
11	Level Recorder	B and K	2305	95011	Range 50 db Calibrated 10-17-66
12	Vacuum Tube Voltmeter	Ballantine	320	N/A	True RMS Range -80 to +40 db Calibrated 8-12-66
13	Dynagage	Photocon	DG-605	654	Range 0-15 KHZ

Table 3-2

ACOUSTICAL SPECIFICATION

ZONE 1.1.2

HOLDDOWN AND LIFT-OFF PERIODS

35 - 60 FT RADIUS

ONE-THIRD OCTAVE
BAND GEOMETRIC
MEAN FREQUENCY
(CPS)

SOUND PRESSURE LEVEL - DB
LIFT-OFF HOLDDOWN

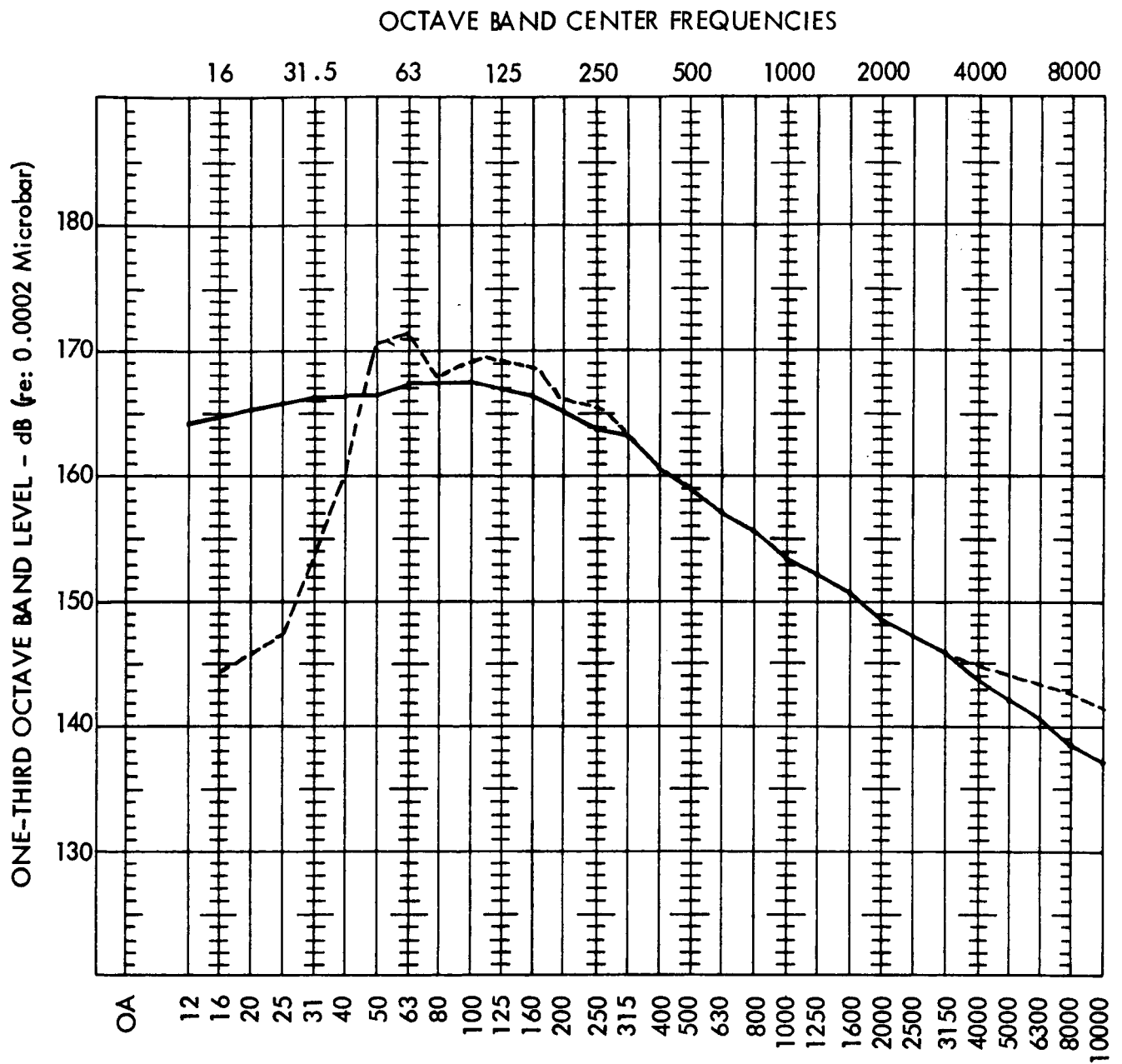
5.0	163.0	134.5
6.3	163.5	136.5
8.0	164.0	138.5
10.0	164.5	140.0
12.5	164.5	141.5
16.0	165.0	143.0
20.0	165.5	144.5
25.0	166.0	145.5
31.5	166.5	146.5
40.0	166.5	147.5
50.0	167.0	149.0
63.0	167.5	149.5
80.0	167.5	150.5
100.0	167.5	152.0
125.0	167.0	152.5
160.0	166.5	152.5
200.0	165.5	153.0
250.0	164.0	154.0
315.0	163.5	154.0
400.0	161.0	154.0
500.0	159.0	153.5
630.0	157.5	153.0
800.0	156.0	152.5
1000.0	154.0	151.5
1250.0	152.5	150.0
1600.0	151.0	149.0
2000.0	149.0	148.0
2500.0	147.5	146.5
3150.0	146.0	145.0
4000.0	144.0	143.5
5000.0	142.5	142.0
6300.0	141.0	140.5
8000.0	139.0	139.0
10000.0	137.5	137.0

OVERALL SOUND
PRESSURE LEVEL

179.0

165.0

FIGURE 3-1 REQUESTED AND APPROVED TEST SPECTRA



----- Test Spectrum

———— Requested Test Spectrum.

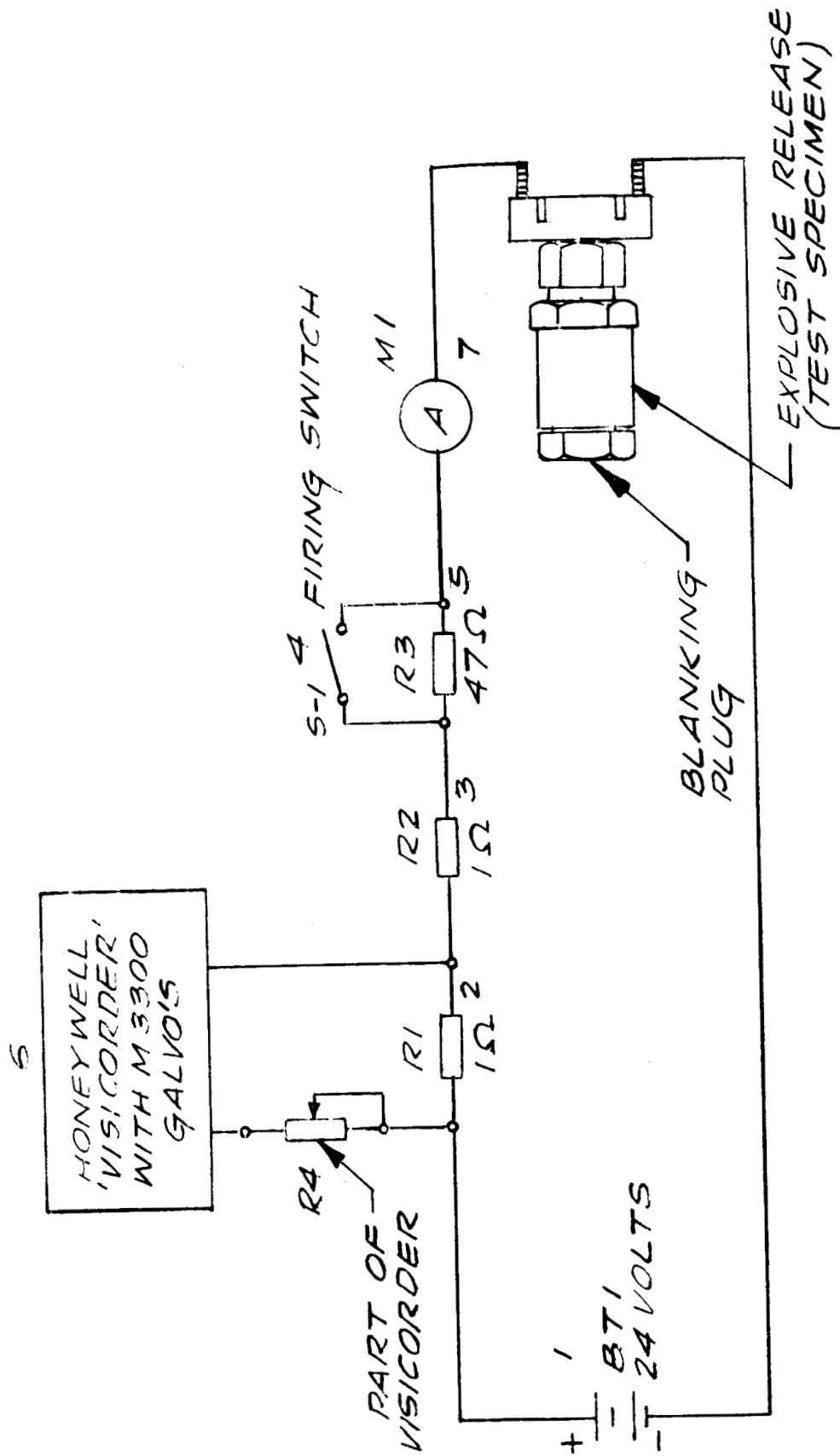


FIGURE 3-2 CONTINUITY AND FIRING CURRENT MONITORING CIRCUIT FOR EXPLOSIVE RELEASE

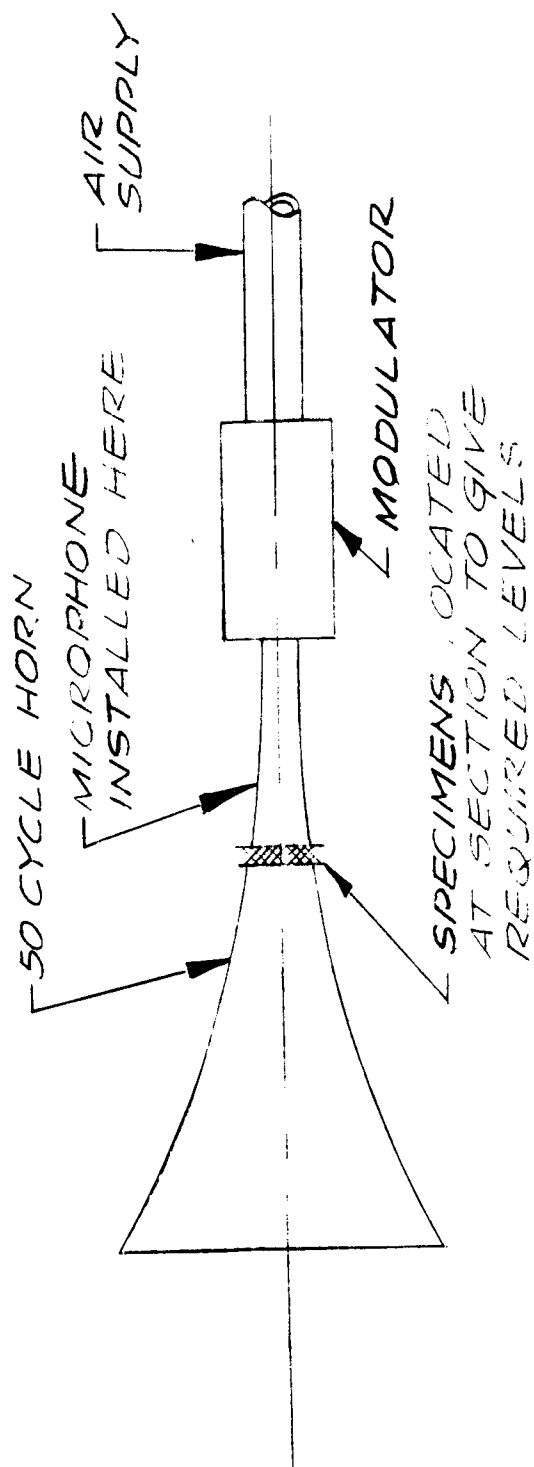


FIGURE 3-3 TEST METHOD OF EXPLOSIVE RELEASE
SEE FIGURE 3-4 FOR PHOTOGRAPH

FIGURE 3-4 EXPLOSIVE RELEASE MOUNTED ON ELASTIC CORD IN HORN

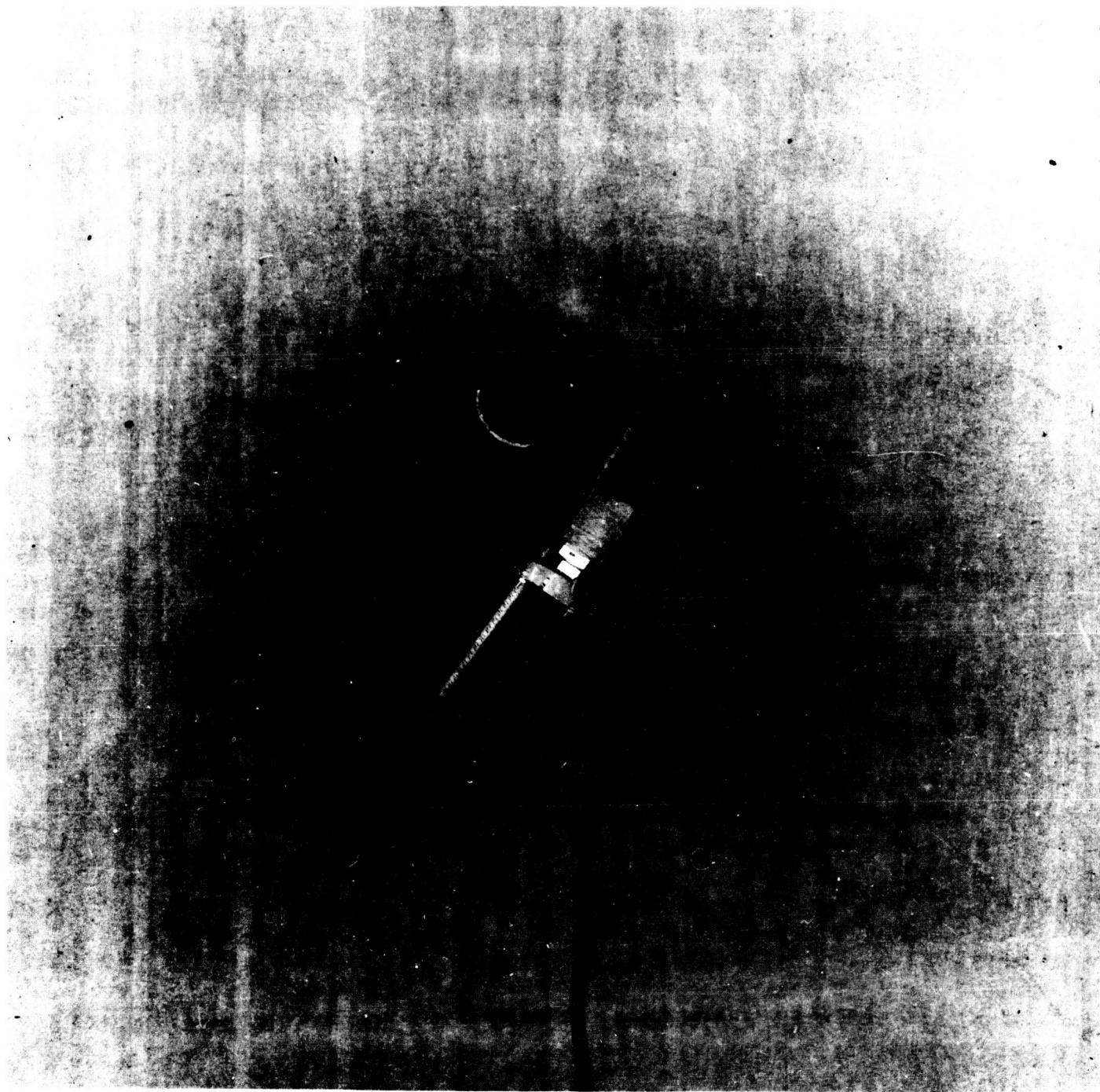
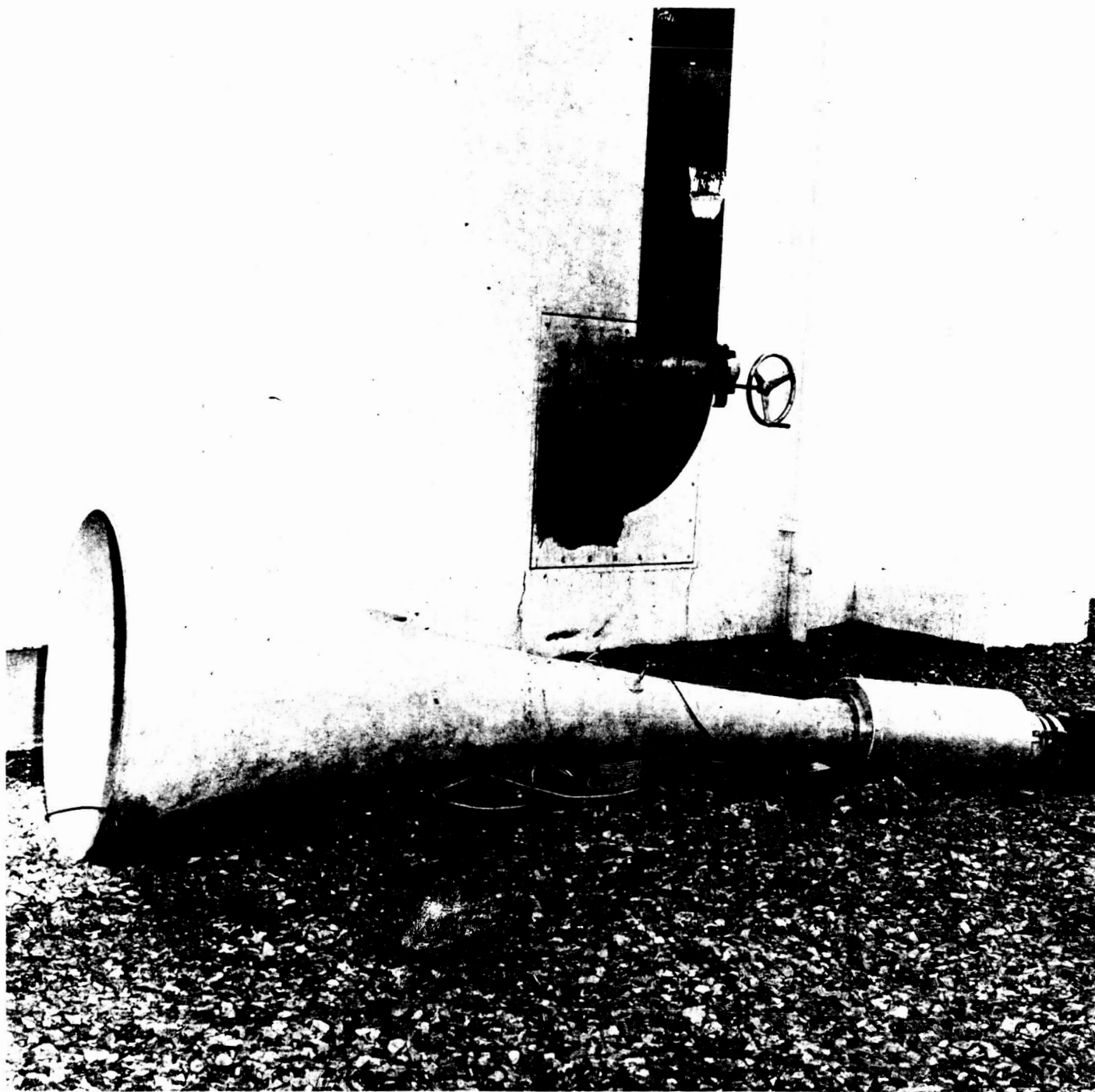


FIGURE 3-5 TEST SET-UP FOR ACOUSTIC TESTS ON EXPLOSIVE RELEASE



One-Third Octave Band Level (dB)
(re. 0.0002 Microbar)

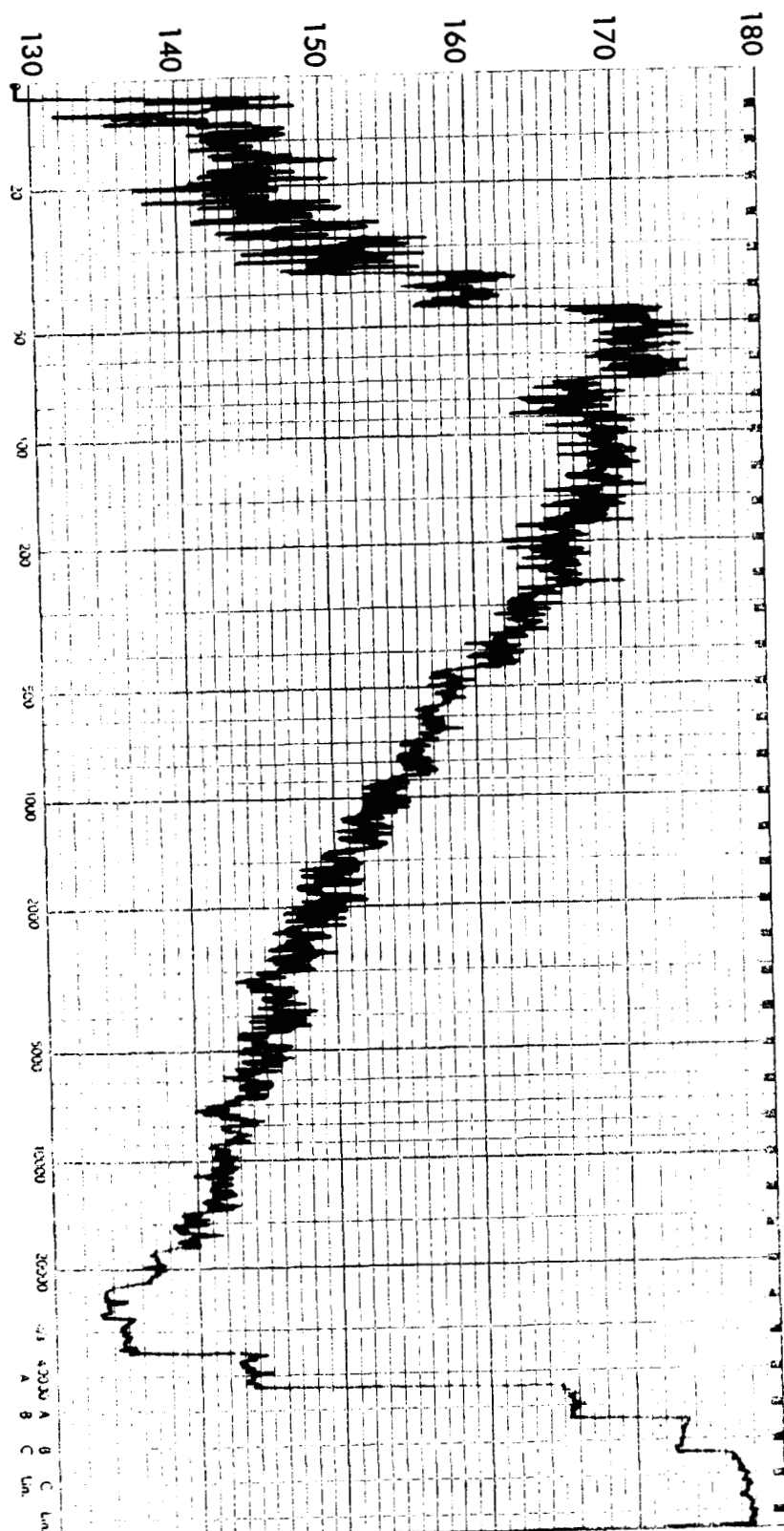


Figure 3-6 Measured Test Spectrum

SECTION IV

FINAL INSPECTION AND DETONATION

4.1 PURPOSE

- 4.1.1 The purpose of this test is to verify that the acoustic environment had no effect upon the internal characteristics of the explosive charge and that the explosive release had suffered no degradation of performance which could be directly related to the acoustically imposed environment.

4.2 REQUIREMENTS

- 4.2.1 The internal resistance of the explosive charge was accurately determined and recorded for comparison with the original resistance as measured during Receiving Inspection (See Table 2-4).
- 4.2.2 Each specimen was to be detonated by applying approximately ten amperes of current to the explosive charge. The actual current applied and the time-to-detonate was to be recorded. The time-to-detonate is defined as that time (From T-0) that current is applied until continuity of the circuit is broken (indicating detonation). It was visually and audibly determined, from a safe observation point, that detonation had actually occurred.

4.3 PROCEDURE

- 4.3.1 The equipment used for this test is listed in Table 4-1.
- 4.3.2 The resistance of each explosive charge was measured and recorded.
- 4.3.3 The bolt with the explosive charge was placed at a remote location, away from operating personnel. A safety officer was in constant attendance to see that no personnel wandered into the area and the area was properly roped off with sufficient warning signs posted. The bolt and explosive charge was covered to protect against any flying particles.
- 4.3.4 The explosive charge was connected to the circuit shown in Figure 3-2 for firing.
- 4.3.5 The recorder used to indicate the current and time-to-detonate was started.
- 4.3.6 Switch S-1 (Figure 3-2) was placed in the closed position to detonate the explosive charge.
- 4.3.7 It was determined the explosive charge had detonated both visually and audibly. The recorder was stopped and the bolt (with the expended explosive charge) was removed from the circuit and examined.
- 4.3.8 Specimens 89 and 90 were subjected to the above procedure, although these two specimens had not been subjected to the acoustic environment, to check-out the circuitry, and to make sure the recorder would function properly.

4.3.9 Steps 4.3.1 through 4.3.7 were repeated for specimens 79 through 87.

4.3.10 Steps 4.3.1 through 4.3.7 were repeated for specimen 88 with the exception that the bolt with the explosive charge was threaded into a special slotted nut and the machined blanking plug was placed in the open end of the special slotted nut prior to detonation.

4.4 RESULTS

- 4.4.1 The measured resistances of the twelve explosive charges is recorded in Table 4-2. A comparison of these measured values with the initial resistance values (see Table 2-4) will show the resistance values of all twelve explosive charges to be slightly less than the initial values. This occurred on specimens 89 and 90 which had not been subjected to the acoustic environment. The difference between the two tabulated readings for each specimen is due to the fact that, at the insistence of the safety officer present, the resistances subsequent to the acoustic testing were measured at the end of a cable with the explosive charge placed in a safe area. The initial resistance measurements were made using short test leads with no measurable resistance. The resistance of the cable was measured at 1.915 ohms and 1.935 ohms before and after the bolt-plus-cable resistance were measured. This variation appeared to be due to the type of attachment made to the bolt terminals.
- 4.4.2 All of the bolts, with explosive charges, were detonated successfully by the application of approximately 9.8 amperes. The time-to-detonate each device occurred at slightly under 0.005 seconds. The actual currents applied and times-to-detonate were recorded, the recordings are available from the test agent upon request.
- 4.4.3 Due to the fast rise and decay time of the detonation current, it was found difficult to obtain good traces from the Visicorder oscillograph. The oscillograph was therefore supplemented by an oscilloscope on Polaroid photography. A sample of a photographed oscilloscope trace is shown in Figure 4-1. Each centimeter on the oscilloscope scale is equivalent to 0.005 seconds. The oscillations immediately following the current rise, shown on the trace, are believed to be due to inductive loading of the firing cable.
- 4.4.4 Visual examination of the firing area around specimens 79 through 87, 89 and 90 showed small pieces of bronze shrapnel from the explosive charge shell. Sections from the lower portion of the bolts, the metal between the four holes in the bolt, were also found to have been broken off from the force of the explosion.
- 4.4.5 Visual examination following the detonation of specimen 88 showed the special slotted nut to be completely broken into two halves, one break occurring at the slot and the other break almost exactly opposite. There were indications of minute particles of bronze. The lower portion of the bolt was found to be intact, no pieces were broken from the bolt as in the previous cases. There was evidence of thread damage to the machined blanking plug as well as the bolt.

4.4.6 The results of this test show the explosive release suffered no adverse effects or degradation of performance after exposure to the acoustic environment. The test results indicate no detrimental effects to the explosive force due to acoustic exposure.

4.4.7 In previous testing none of the special slotted nuts completely split. It should be pointed out, however, that in all previous tests using the explosive release, whenever the explosive charge had been detonated, the explosive release had been under a tension load, creating a dynamic situation (reference Test Reports CCSD-FO-1060-3S, Phase B and Phase C). In this test the explosive release was not in tension, although a blanking plug was threaded into the open end of the special slotted nut to more closely approximate actual installed conditions. The condition here could be compared to a static situation, where instead of the plug being pulled free of the special slotted nut due to a tension force it had to be blown free by the explosive force. This condition allowed more time for gaseous build-up, caused by detonation of the explosive charge, within the special slotted nut, with the resulting higher forces evidenced.

TABLE 4-1 Final Inspection and Detonation Equipment List

ITEM NO.	NOMENCLATURE	MANUFACTURER	MODEL PART NO.	SERIAL NO.	REMARKS
1	Battery	N/A	N/A	N/A	24 Volts
2 & 3	Resistor (2 required)	N/A	N/A	N/A	1 ohm 100 watts
4	Snap Action Switch	Micro-Switch	N/A	N/A	Heavy-duty 15 - Amperes
5	Resistor	N/A	N/A	N/A	47 ohm 50 watts
6	Visicorder	Honeywell	1012	N/A	Calibrated 6-3-66
7	Ammeter	Weston	931	61979	Range 0-10 amperes Calibrated 10-18-66
8	D-C Micromultimeter	Dynamics Instruments	4132	4132-0068	Range 1 x 10 ⁻⁴ Volts 1 x 10 ³ Volts Calibrated 8-23-66

FIGURE 4-1 OSCILLOSCOPE TRACE OF FIRING CURRENT
SHOWING TIME-TO-DETONATE

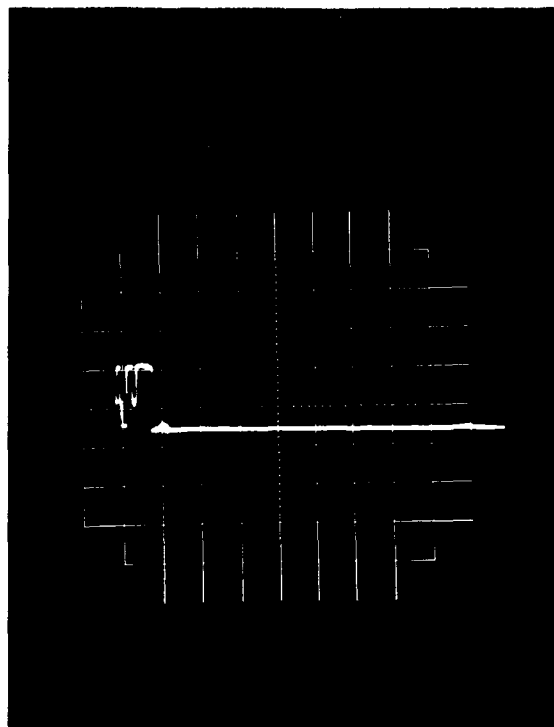


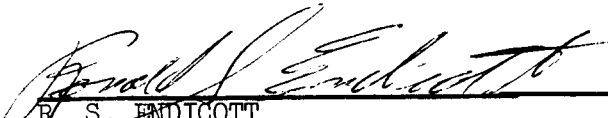
TABLE 4-2 RESISTANCE MEASUREMENTS SUBSEQUENT TO ACOUSTIC TESTS

Serial No.	79	80	81	82	83	84	85	86	87	88	89	90
Resistance (ohms)	0.405	0.39	0.41	0.39	0.395	0.365	0.405	0.39	0.385	0.395	0.385	0.385

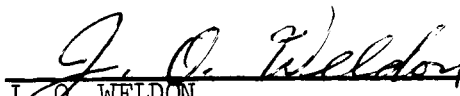
APPROVAL
TEST REPORT
EXPLOSIVE RELEASE

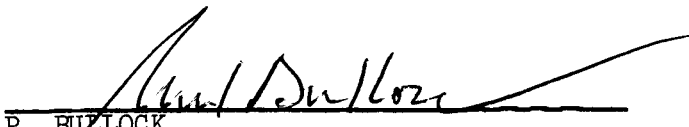
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